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RSA (1-9731-4

EXEMPTION EVALUATION FORM

EXEMPTION EVALUATION  
FORM  
LOGG 10 11 11 35

PART 1 APPLICANT

1A. Exemption Number : 12706-N

Application Number: 40418

Project Officer : Cheryl West Freeman

1B. Date of Application: 4/20/01

1C. Name of Applicant: Ola Johnsrud

Title: Quality Assurance Manager

Company Name: RAGASCO AS  
(formerly Raufoss Composites AS))

Address: Box 50  
2831 Raufoss, Norway

Phone Number: 47 6115 2923

1D. U.S. Agent for foreign applicant or Consultant Name:  
John Neumann

Company name:

Address: 18 McIntosh Road  
Hilton Head Island  
SC 29926

Phone Number: (843) 689-9935

Fax: (843) 689-9936

1E. Summary of What Applicant is Requesting:

To authorize the manufacture, marking and sale use of a non-DOT specification fully-wrapped fiberglass composite cylinder with a seamless, non-load sharing blow-moulded thermoplastic liner for the transportation of the materials specified herein.

1F. Regulation(s) exempted: 173.304a(a)(1) and 175.3 in that the prescribed packaging is not authorized therein.

1G. Modes of Transportation:

|                          |                        |
|--------------------------|------------------------|
| 1 Motor Vehicle ( X )    | 2 Rail Freight ( X )   |
| 3 Cargo Vessel ( X )     | 4 Cargo Aircraft ( X ) |
| 5 Passenger Aircraft ( ) |                        |

**PART 2 REVIEW FOR DOCKETING**

- ( X ) Application contains sufficient information to support docketing.
- ( ) Application is incomplete or unnecessary and should be returned for the following reason(s).

**PART 3 HAZARDOUS MATERIALS**

3A. Hazardous Materials to be shipped:

| Proper Shipping Name/<br>Hazardous Materials Description | Hazard<br>Class/<br>Division | Identi-<br>fication<br>Number | Packing<br>Group |
|--|------------------------------|-------------------------------|------------------|
| Butane   | 2.1                          | UN1011                        | N/A              |
| Hydrocarbon gas mixture,<br>liquefied n.o.s.             | 2.1                          | UN1965                        | N/A              |
| Petroleum gases, liquefied                               | 2.1                          | UN1075                        | N/A              |
| Propane  | 2.1                          | UN1978                        | N/A              |

3B. Is the hazardous material capable of being detonated? (If No - go to 3C) No

If so, under what conditions?

- (1) What special precautions have been taken to prevent these conditions in transportation?
- (2) Has the hazardous material been classed as an explosive? \_
  - Has it been tested and approved under § 173.56?
  - Is stabilization required and what type?

3C. Other risks presented by the material that warrant special assessment. (e.g. flammable or toxic gases produced upon contact with water, material can initiate or enhance a fire,

article or device contains an ignition source) NONE

#### **PART 4 PACKAGING**

4A. Is the applicant seeking an exemption from the packaging requirements? YES  
(If No - Go on to Part 5)

4B. ☐ Non authorized specification package.  
☐ Authorized Specification package with quantity or size variation.  
☐ Material change.  
☐ Over authorized pressure.  
☒ Non specification package. Most comparable spec. package. DOT FRP-1

4C. What are the possible failure modes of the packaging? Leak or rupture

Is the material of construction appropriate? Yes

Will the packaging integrity be sufficient? Yes

In the case of a pressurized packaging, will the package adequately contain any pressure that might develop? Yes

Does packaging meet the performance requirements for air transportation? Yes

Have evaluation of tests results shown the package to be equivalent? Yes

4D. Are special handling measures needed (specify)? No

#### **PART 5 SPECIAL TRANSPORT AND INFORMATIONAL CONTROLS**

5A. Is the applicant seeking an exemption from Special Transport and Informational Controls? (If No - go to Part 6) No

5B. Indicate control from which variance is sought. (i.e., placarding requirements, etc.)

5C. What controls have been offered or might be appropriate to mitigate risks otherwise presented with the exemption?

- 5D. What special data collection and reporting requirements are needed to document experience and exemption performance?

#### **PART 6 SHIPPING EXPERIENCE**

- 6A. What has the generally shipping experience been with this type of material, package, and operation? The experience in Europe has been satisfactory
- 6B. Can any rough estimate be made on the extent of the use of this exemption? How many shipments will be made and how much material will be transported? Not known.
- 6C. Is this a new package with no shipping experience? Yes.

#### **PART 7 SAFETY AND RISK ASSESSMENT**

- 7A. 49 CFR § 107.105(d) prescribes requirements for justification of an exemption through comparisons with established levels of safety and risk assessment. Has the applicant demonstrated equivalent levels of safety or provided an appropriate risk analysis? Yes
- 7B. What are the hazards (worst case) posed by the proposed exemptions? What could go wrong? Are the risks significant? What is the degree of uncertainty as to likelihood or consequences? The risks have been identified and addressed.
- 7C. What are the benefits to the public and the applicant of granting the exemption? What trade-offs have been made?
- 7D. Does this exemption (and other similar exemptions) point to the need for possible regulatory changes? No If so what other information is needed to support a regulatory change.

#### **PART 8 DOCKET COMMENTS/INFORMATION**

- 8A. Date checked: 4/28/03 *None as of 7/18/03*
- 8B. Comments: None (If Yes, summarize)
- 8C. Has **CONFIDENTIAL** or **PROPRIETARY** information (49 CFR 107.5) been considered in this application? Yes

#### **PART 9 OVERALL EVALUATION & RECOMMENDATION**

Provide standard of equivalency and rationale supporting equivalent level of safety or comment on additional requirements needed to establish equivalency.

Include main issues, evidence (i.e. tests), and technical conclusions. See note in Part VI concerning confidential information.

Ragasco requests an exemption in order to manufacture, mark, sell, and use a non-DOT specification composite cylinder for the transportation of liquefied petroleum gas and other Division 2.1 materials. The cylinder is a fully-wrapped fiberglass cylinder with a seamless, non-load sharing blow-moulded thermoplastic liner. The cylinder is manufactured in accordance with the ISO 11119-3-2002 Standard, "Composite Fully Wrapped Non-Metallic and Non-Load Sharing Metal Liners including Non-Lined  $\leq 30$  bar  $P_h$ ". The cylinder is also designed to the CEN 12245 European Standard which is very similar to ISO 11119-3. The proposed cylinders and RAGASCO have been approved in all EC countries in accordance with Transportable Pressure Equipment Directive (TPED), giving the right to "pi" mark the cylinders. This is a precedent setting request for RSPA. The (attached) FACT SHEET provides the significant design, manufacturing, and use details of the proposed exemption cylinder.

The project officer's review of the ISO Standard 11119-3, the CEN 12245, and the DOT FRP-1 Standard for fully wrapped fiberglass, aluminum lined cylinders revealed that many of the design qualification tests are the same between the three standards (e.g. environmental cycling). The ISO and CEN Standards require additional tests that are not required by the DOT FRP-1, including flawed cycle/burst tests, a torque test for the neck boss, and drop tests. The ISO and CEN standards require a permeability test, which is not applicable to the aluminum-lined DOT FRP-1 Standard. In the cases where testing is not required by the ISO or CEN standards, RAGASCO meets the applicable design requirements of the DOT FRP-1 Standard.

All approval testing and certification testing (design qualification testing) was performed under third party inspection by TUV Bayern (Germany). RAGASCO requested that inspection and testing during manufacture of the proposed cylinders be conducted under the competent inspector of the manufacturer. For most low pressure DOT specification cylinders, no third party inspection is required. RAGASCO's request should not be granted for the proposed cylinder because the cylinder is of all-composite construction, and it is not manufactured in the US. Independent third party inspection should be a requirement of the exemption.

Manufacture of the proposed cylinders will be performed in accordance with the Quality Assurance Program Plan (Marked Confidential) on file with the OHMEA. The plan covers supplier follow up, extensive receiving inspection, manufacturing processes, automatic data collection, testing, product audits, work station audits, and more.

RAGASCO submitted design qualification test reports to demonstrate conformance with the ISO/CEN/FRP requirements. These test results are on file with the Office of Hazardous Materials Exemptions and Approvals (OHMEA). Based on the design

requirements, an appropriate level of safety is met. DOT had a few concerns with the ISO 11119-3 Standard before it was adopted at the UN. The concerns were with the two piece, linerless composite design, which does not apply to the proposed RAGASCO design. There were also concerns about the appropriateness of the temperature of 15°C for the permeability test.

The project officer had a great deal of correspondence, and telephone calls with the applicant to try to obtain additional information in order to be able to evaluate the request for exemption. RAGASCO staff met in the DHM-20 offices a few times to exchange information. Some of the additional information that was requested from the company was: material information on the HDPE liner, retest criteria, design qualification test results, failure modes and effects analysis, compatibility of the liner with the LPG, and design drawings. All responses from RAGASCO were satisfactory.

Requalification and prefill inspection of the RAGASCO cylinder will rely heavily on a visual inspection. Criteria for the visual inspection (Attachment A of the exemption) was taken from draft document CEN/TC 286 Transportable refillable composite cylinders for Liquefied Petroleum Gas (LPG) - Periodic requalification. This is the best information available at this time for the visual inspection of the type of cylinder in question.

An issue with the non-metal liner is the permeability. The ISO and CEN standards require that the cylinder be weighed empty before and after the test and cycled 1,000 times from 0 to service pressure at 15°C. The cylinder must be weighed after 1, 7, 14, 21, and 28 days. The maximum weight loss of the cylinder is 0.25 ml/h/l water capacity. For the RAGASCO cylinder, this corresponds to a permeability rate of 103 g/yr. DHM-20 requested additional permeability testing be performed at 130°F to reflect more realistic North American transportation temperatures. The test at the higher temperature resulted in exponentially higher permeability. This is expected behavior for a plastic liner. DHM-20 then requested a safety/risk analysis, centering around scenarios of transportation and storage at appropriate temperatures.

The risk assessment team of DHM-20 reviewed RAGASCO's analysis. (SEE ATTACHED MEMO). Based on the evaluation of RAGASCO's analysis, we recommend that the exemption include prohibitions on storage in unventilated areas and a requirement to transport in a well-ventilated truck.

RAGASCO requested a service life longer than 15 years based on the ISO and European standards. It is recommended that the cylinder service life be limited to 15 years, which is the limit for the FRP-1, 2 and CFRC composite cylinders that are authorized under exemption in this country. \*

It is recommended that this exemption be granted.

\* 15yr life, design basis is 30yr criteria minimum per ISO 11119-3,

SS 9/6/2003

Office of Hazardous Materials Technology (OHMT)

Office of Hazardous Materials Exemptions and Approvals (OHMEA)

Office: DHM-22.2

Project Officer/Date: Cheryl West Freeman 5/29/03

Reviewer/Date:

*[Signature]* 7/18/2003 to 9/9/03

Office Director/Date:

*[Signature]* 8/1/2003

Attachments (A) (B) Fact Sheet, Risk Memo

ATTACHMENT = Fact Sheet

RSA-01-9-131

E 12706

**RAGASCO COMPOSITES APPLICATION FOR EXEMPTION #12706**

**FACT SHEET**

- Liner: Non-load sharing, seamless, blow-moulded thermoplastic liner. High density polyethylene (HDPE). Typical burst pressure 4 bar.
- Composite: 75% Fully wrapped-fiberglass. Resin based on vinylester.
- Size: 10 kg, 23.8L water capacity, Tare wt 6.7 kg
- Service: Leisure market/consumer
- Commodities: LPG, Propane, Butane, Hydrocarbon gas mixture, liquefied n.o.s.
- Outer casing: Permanently attached. Injection moulded HDPE. Covers 80% of cylinder.
- Service life: Limited to 15 years
- Service press: 20 bars (294 psi)
- Test press: 30 bars (441 psi) (ISO/CEN 3/2 sp)
- Burst press: 60 bars (882 psi)
- Boss: HDPE with 20 - 30% glass fiber, hot plate welded to the liner
- Manufacture: Automated production. QA program - ISO 9001, AQAP110 in 1994. Workstation audits and product audits, automatic data collection.
- Approvals: ADR type approvals based on testing iaw prEN 12245 Feb 1999- all EC countries iaw Transportable Pressure Equip Dir CTPED pi mark
- Inspection: Homologation testing (des qual) coordinated, witnessed, documentd by TUV Bayern. Included audit of manufacturing facilities and documents.
- Product audits: 2 completed cylinders per ea batch produced
- internal/ext visual
  - volume measurement, height, diameter
  - weight
  - pull test on outer casing
  - cut welded parts, study weld zone
  - unscrew valve, measure torque
  - burst 1 cylinder per batch. cut cyl, measure wall thickness
  - cycle one cylinder per 5 batches

Cheryl W. Freeman, DHM-20, 8/8/02

A



BSH 01-9/131

12/26

**Memorandum for Record**

(B) H/T/kt/hif ad.

Date: April 2, 2003

Subject: Evaluation of Risk Documentation Submitted by Ragasco in Support of an Exemption Request for Plastic Lined Composite Cylinders

By: A. Douglas Reeves, Risk Assessment, DHM-24

**Background:**

Cylinders currently approved for transportation of hazardous materials are typically metal or metal lined. Permeability (the ability of a gas to move through the vessel wall) for this type of cylinder is, for all practical purposes, zero. However, the plastic lined composite cylinders which are the subject of the Ragasco exemption application are permeable allowing approximately 100 grams of the contents to escape per year at 100 degrees F. Permeability increases at higher temperature.

One of the concerns in this precedent-setting exemption application is the effect of permeability on the risk posed during transportation and use of this type of cylinder. RSPA/OHMS asked Ragasco to provide analysis to determine if the permeability was high enough to cause the lower flammability limits for liquified petroleum gases (LPG) to be reached in reasonable transportation and use scenarios. Note that the scope of the analysis extends beyond transportation because hazardous material transportation regulations function to a certain degree as defacto standards in the use environment.

**Analysis and Results:**

Three scenarios were modeled and examined by Ragasco at the request of RSPA/OHMS: (1) storage of the cylinder in the trunk of a car where elevated temperatures could occur; (2) transportation in a vehicle with a number of other cylinders; (3) storage in a closed area in a home.

The probability of a Case 1 critical incident was determined to be low. Infrequent occurrence of this type of event and natural (as a result of temperature cycling) ventilation are factors in this result. (Note that the analysis does not provide a time to reach the lower flammability limit in this instance.)

Case 2 was also determined to be of low probability. LPG cylinders should not be transported in an enclosed space such as a box truck or van (CGA Pamphlets P1, SB-2; NFPA 58). This, coupled with relatively short, defined transit times and the likelihood that professional transporters will follow regulations and guidelines, limits the chance of occurrence. (Note that the analysis indicated that transportation in a closed truck with 1200 cylinders with a peak high temperature would take 3 to 5 days for the lower flammability limits to be reached.)

Case 3 is the highest probability event calculated, by at least two orders of magnitude, and

represents the scenario of greatest concern. Case 3 assumes that the cylinder will be placed in a small confined, unventilated storage space in a home, such as a cabinet in a basement. Although such storage is prohibited in the United States, it can occur, particularly in the consumer environment. Case 3 assumes a relatively high (80 degrees F) constant temperature with no air infiltration. It is set up to represent a worst-case scenario.

Ragasco determined that it would take 174 days, or approximately 6 months, to reach the lower flammability limits for LPG in the confined storage space due to the permeability of the cylinder. Although undisturbed storage of such duration is unlikely, it is not implausible.

Ragasco goes on to calculate the probability of an event resulting from permeability and reaching the lower flammability limits. The results are shown in Table 1. A couple of the assumptions in the calculations are questionable. Table 2 recomputes the probability to determine sensitivity of the results to these assumptions. Specifically, assuming a specific temperature and performing the calculation on that basis may negate the permeability > 100 g/y factor (the probability becomes 1). Similarly, the probability of not smelling the LPG before an ignition source is present may be too high in this scenario (no ventilation) and again the probability is assumed to be 1.

Thus the resultant worst-case scenario has an upper bound probability of 8.1225E-07, or about one in a million. In fact, the probability is likely much lower considering that the assumption that no infiltration will occur is an extreme one. Infiltration should significantly increase the time for the lower flammability limit to be met and may preclude the possibility in many circumstances.

The question may arise as to whether higher permeability rates should be allowable in future applications. It may be advisable to limit consideration to this permeability rate or less. Even then, testing, periodic retesting, and manufacturing controls may be appropriate to ensure higher rates do not occur in practice. Also, the question of a permissible permeability rate versus the size of the cylinder may be worth investigating in the future.

#### Conclusion:

There is a very small but finite possibility that the use of cylinders of the type proposed by this exemption could pose a danger in certain circumstances.

The applicant suggests that valve leakage poses comparable risks. The point is valid and the comparison is useful in evaluating risk implications. Seal leakage and the possibility of the user not adequately tightening valves are reasons cylinders are not to be stored in unventilated or interior spaces in the United States. However, the effects of permeability are additive to other risks and will increase the total risk of interior storage in certain circumstances. The risks border on negligible but cannot be dismissed entirely.

#### Recommendation:

If other aspects of the exemption evaluation suggest that equivalent levels of safety are maintained but for the permeability issue, consider adding a marking requirement to the cylinder

as a condition of the exemption. The marking would ensure the user is more prominently warned about the potential danger of inside storage of any cylinder.

A visible label or marking stating something along the lines of “cylinders should not be stored inside the home or in unventilated spaces” should more than offset any risk due to permeability of the cylinder proposed for use in this application. The public awareness created by such markings could be expected to reduce the instances of interior storage and the risks due to either leaking or loosely closed valves or cylinder permeability.

Table 1

Probabilities as Computed by Ragasco

| Factors\probability                                     | Closet in house   |
|---|-------------------|
| Probability for the situation to happen                 | 0.001             |
| Permeability > 100g/y                                   | 0.00001           |
| Drain from the space smaller than LPG loss              | 0.9               |
| No attention for a long period                          | 0.1               |
| Do not smell the loose LPG before presenting ign.source | 0.001             |
| The total amount of loose gas has critical energy level | 0.95              |
| There is oxygen involved                                | 0.95              |
| Ignition source present                                 | 0.01              |
| <b>Probability for critical incident</b>                | <b>8.1225E-15</b> |

Table 2

Probabilities Used in Sensitivity Analysis

| Factors\probability                                     | Closet in house   |
|---|-------------------|
| Probability for the situation to happen                 | 0.001             |
| Permeability > 100g/y                                   | 1                 |
| Drain from the space smaller than LPG loss              | 0.9               |
| No attention for a long period                          | 0.1               |
| Do not smell the loose LPG before presenting ign.source | 1                 |
| The total amount of loose gas has critical energy level | 0.95              |
| There is oxygen involved                                | 0.95              |
| Ignition source present                                 | 0.01              |
| <b>Probability for critical incident</b>                | <b>8.1225E-07</b> |